

FSA's FUTURE ROLE

JET PROPULSION LABORATORY

W.T. Callaghan ✓

Future Role

• OBJECTIVES

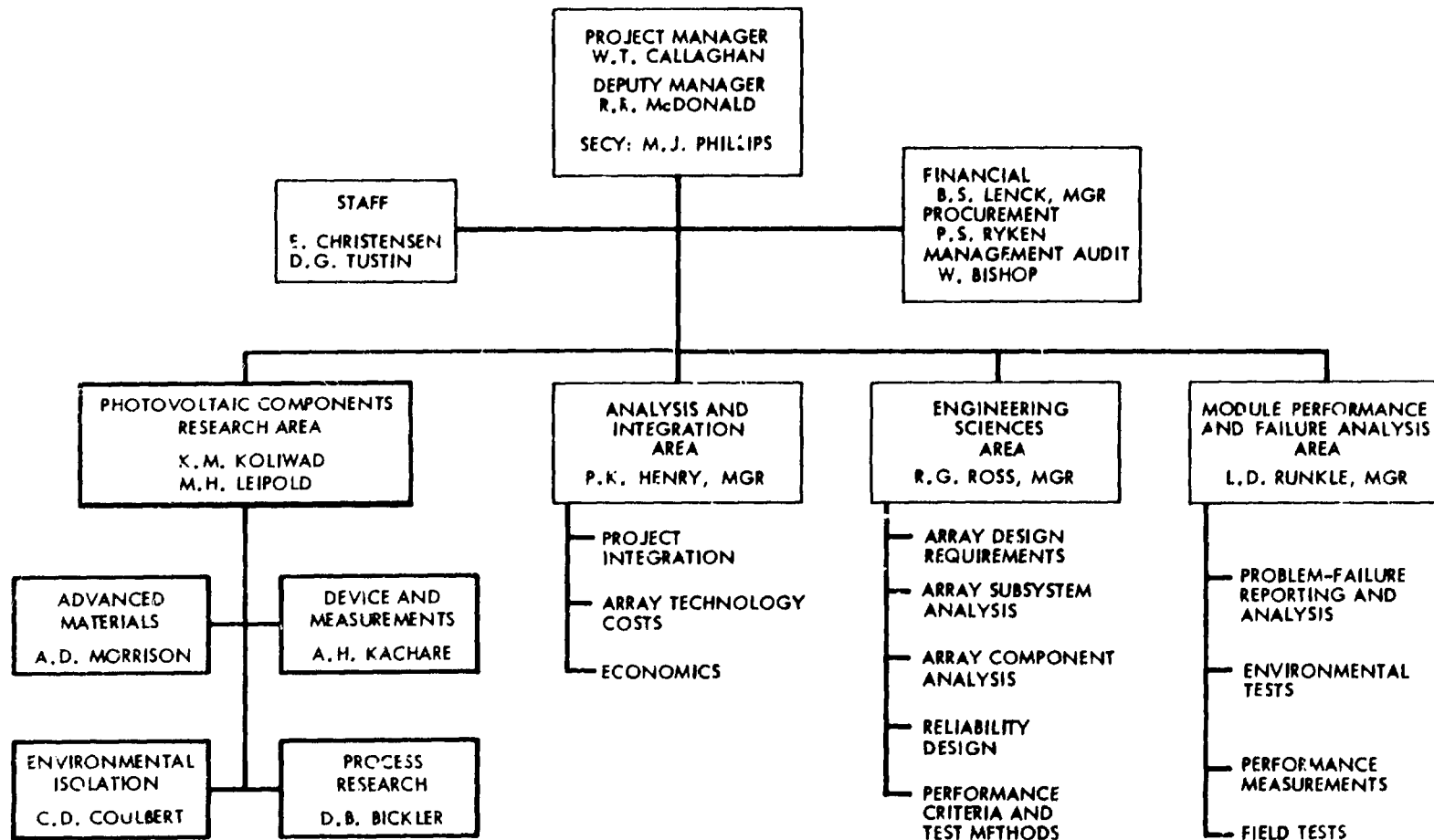
- TO PURSUE ADVANCED CRYSTALLINE SILICON PV TECHNOLOGIES FOR POTENTIAL USE LATE IN THE 1980s AND IN THE 1990s
- TO CONTINUE SPONSORSHIP OF RESEARCH AND TECHNOLOGY EVOLUTION ON ADVANCED THICK-MATERIAL FLAT-PLATE PHOTOVOLTAIC MODULES AND ARRAYS
- TO COMMENCE THE ACTIVITIES REQUIRED TO MOVE THIN-FILM TECHNOLOGIES INTO MODULE DEVELOPMENT
- TO CONTINUE TO STIMULATE TRANSFER OF KNOWLEDGE THROUGHOUT THE PHOTOVOLTAIC COMMUNITY

Project Plans

- TO SPONSOR TECHNOLOGY ACTIVITIES THAT HAVE THE POTENTIAL FOR MAKING MODULES/ARRAYS VIABLE FOR LARGE-SCALE APPLICATIONS, SUCH AS CENTRAL STATIONS AND ROOF-TOPS
- TO STRIVE FOR HIGH EFFICIENCY COUPLED WITH SIGNIFICANT COST REDUCTION FOR LOWEST POWER GENERATION COSTS
- TO REDUCE TECHNICAL BARRIERS TO HIGH-PERFORMANCE, LONG-LIFE, RELIABLE MODULES AND ARRAYS
- TO CONTINUE TO FUND UNIVERSITIES, INDUSTRY, AND OTHER ORGANIZATIONS FOR PERFORMANCE OF MOST OF THE WORK
- TO CONTINUE ECONOMIC ANALYSIS TECHNIQUES FOR COMPARISON OF ALTERNATIVE RESEARCH OPTIONS

FLAT-PLATE SOLAR ARRAY PROJECT

PLENARY SESSION: W.T. CALLAGHAN



New Task Objectives

TO EXTEND OUR KNOWLEDGE AND CAPABILITIES TO USE THE FOLLOWING TECHNOLOGIES FOR PHOTOVOLTAIC COMPONENTS:

- **ADVANCED MATERIALS (A.D. MORRISON)**
SILICON AND NON-SILICON MATERIAL SYNTHESIS,
PREPARATION AND SHEET GROWTH FOR PHOTOVOLTAIC
DEVICES
- **DEVICE AND MEASUREMENTS (A.H. KACHARE)**
DEVICE STRUCTURE, MATERIAL-DEVICE PROPERTY
INTERACTION, SILICON AND NON-SILICON DEVICE
PHYSICS, MEASUREMENT TECHNIQUES FOR PHYSICAL,
CHEMICAL AND ELECTRICAL EVALUATION, AND
MATERIAL CHARACTERIZATION
- **ENVIRONMENTAL ISOLATION (C.D. COULBERT)**
ENCAPSULATION MATERIAL FORMULATION, PROPERTIES,
LIFE-LIMITING DEGRADATION MECHANISMS, MODULE
DURABILITY, PERFORMANCE PREDICTABILITY,
ASSESSMENT METHODOLOGIES AND ADVANCED
PACKAGING CONCEPTS FOR SILICON AND NON-SILICON
DEVICES
- **PROCESS RESEARCH (D.B. BICKLER)**
RESEARCH IN SILICON AND NON-SILICON PROCESS
ELEMENTS SUCH AS SURFACE PREPARATION, JUNCTION
FORMATION, METALLIZATION, ANTI-REFLECTION
COATING, AND SYNERGISTIC EFFECTS OF THESE STEPS
ON CELL AND MODULE FABRICATION

Objectives and Plans

PLENARY SESSION: W.T. CALLAGHAN

SILICON MATERIAL

OBJECTIVE

SPONSOR THEORETICAL AND EXPERIMENTAL RESEARCH ON SILICON MATERIAL REFINEMENT TECHNOLOGY SUITABLE FOR FLAT PLATE SOLAR ARRAYS

PLANS

- CONDUCT RESEARCH IN NEW REACTOR CONCEPTS THAT ENABLE SIGNIFICANT INCREASES IN SILICON DEPOSITION RATES USING CHLOROSILANE AND SILANE PRECURSORS
- CONDUCT RESEARCH IN NEW CONCEPTS FOR FLUIDIZED BED REACTOR TECHNOLOGY FOR CHLOROSILANE OR SILANE CHEMICAL SYSTEMS
- COMPLETE ONGOING EFFORTS TO RESOLVE THE KEY CRITICAL TECHNICAL PROBLEMS REMAINING IN THE SILANE TO SILICON AND THE DICHLOROSILANE TO SILICON PROCESSES

SILICON SHEET

OBJECTIVE

CONDUCT RESEARCH ON THE CRITICAL ELEMENTS OF SILICON SHEET GROWTH TO ACHIEVE THE TARGETS OF A SILICON SHEET TECHNOLOGY COMPATIBLE WITH FUTURE SOLAR CELL REQUIREMENTS

PLANS

- PERFORM RESEARCH ON THE LIMITS TO CRYSTALLIZATION RATES IN SILICON GROWTH
- PERFORM THEORETICAL AND EXPERIMENTAL RESEARCH ON THERMAL STRESSES GENERATED IN THE GROWTH OF WIDE AND THIN SILICON RIBBONS
- PERFORM RESEARCH TO FURTHER UNDERSTANDING OF THE INFLUENCE OF GROWTH AMBIENT ATMOSPHERE CHEMISTRY ON THE CRYSTALLIZATION PROCESS AND SILICON MATERIAL QUALITY
- CONTINUE RESEARCH ON THE BASIC MECHANISMS OF CUTTING SILICON AND THE INTERACTION OF SILICON SURFACES WITH EXPERIMENTAL PARAMETERS
- CONTINUE CHARACTERIZATION OF SILICON SHEET MATERIAL WITH INNOVATIVE TECHNIQUES

CELL AND MODULE FORMATION

OBJECTIVE

SPONSOR RESEARCH ON ADVANCED CELL AND MODULE FORMATION TECHNIQUES

PLANS

- CONDUCT RESEARCH IN THE FORMATION AND CHARACTERIZATION OF ELECTRICALLY CONDUCTIVE SILICIDES
- CONDUCT RESEARCH ON THE INFLUENCE OF POLYCRYSTALLINE GRAIN BOUNDARIES UPON JUNCTION FORMATION AND METALLIZATION
- PERFORM RESEARCH ON THE PHYSICS OF SURFACE FIELD FORMATION
- PERFORM RESEARCH ON THE PHYSICS OF CORROSION REACTIONS AT METALLIC INTERFACES
- CONTINUE RESEARCH ON NON MASS ANALYZED ION IMPLANTATION TECHNIQUES, METALLIZATION AND CELL INTERCONNECTION SYSTEMS, AND MODULE ASSEMBLY TECHNIQUES

ENVIRONMENTAL ISOLATION

OBJECTIVE

SPONSOR RESEARCH ON AGING DEGRADATION CHARACTERISTICS AND THEIR INFLUENCE UPON MODULE DURABILITY AND RELIABILITY

PLANS

- CONDUCT RESEARCH IN LONG TERM PHOTOTHERMAL DEGRADATION MECHANISMS IN POLYMERS, ESTABLISH MODELS AND VALIDATE
- INVESTIGATE ENCAPSULANT INTERFACE STABILITY CRITERIA AS AFFECTED BY BONDING TECHNIQUES, DISSIMILAR MATERIALS, AND OPERATIONAL ENVIRONMENTS
- CONDUCT RESEARCH IN CORROSION MECHANISMS IN MODULE INTERNAL CIRCUIT ELEMENTS, VERIFY DEGRADATION RATES AND CONTROL CRITERIA
- INVESTIGATE OPERATING TEMPERATURE LIMITATIONS IMPOSED BY MODULE DESIGN AND MOUNTING, AND HOT SPOT SENSITIVITY
- INVESTIGATE AND APPLY ACCELERATED AND DURABILITY TESTING TECHNIQUES AND LIFE PREDICTION METHODS

ENGINEERING SCIENCES

OBJECTIVE

SPONSOR RESEARCH ON ADVANCED MODULE AND ARRAY ENGINEERING SCIENCE ACTIVITIES THAT WILL LEAD TO HIGH PERFORMANCE, SAFE, RELIABLE, LONG LIFE DESIGNS

PLANS

- CONTINUE THEORETICAL AND EXPERIMENTAL RESEARCH TO CHARACTERIZE AND DEFINE SAFE, RELIABLE MODULE AND ARRAY DESIGN CONCEPTS AND ASSOCIATED TECHNOLOGY
- CONTINUE TO EVOLVE ANALYTICAL AND EXPERIMENTAL METHODS OF EVALUATING MODULES AND ARRAYS INCORPORATING EXPERIENCE GAINED BY THE PROJECT AND JOE ACTIVITIES

MODULE PERFORMANCE AND FAILURE ANALYSIS

OBJECTIVE

EVALUATE RELIABILITY AND DURABILITY OF MODULES THAT USE MATERIALS AND TECHNIQUES RESEARCHED IN THE PROJECT THROUGH A STRUCTURED PROGRAM

PLANS

- PROCURE MODULE SAMPLES CONSTRUCTED USING INNOVATIVE CONCEPTS
- MEASURE PERFORMANCE CHARACTERISTICS
- IMPLEMENT MEASUREMENT TECHNIQUES NEEDED TO ASSESS MODULE PERFORMANCE IN RESPONSE TO EVOLVING REQUIREMENTS
- PERFORM A BROAD PROGRAM OF ENVIRONMENTAL TESTING IN THE LABORATORY
- PLACE MODULES IN FIELD SITES FOR ENDURANCE TESTING
- CORRELATE FIELD AND LABORATORY TESTING RESULTS TO EVALUATE THE ENVIRONMENTAL TESTING PROGRAM
- PERFORM DIAGNOSTIC ANALYSES OF MODULE PROBLEMS OR FAILURES

FSA Project Meetings

- REDUCE NUMBER OF PIMS PER YEAR
 - TWO IN 1982
 - ONE OR TWO IN 1983
- CONDUCT IN-DEPTH TECHNICAL WORKSHOPS
 - LOW-COST SOLAR ARRAY WAFERING WORKSHOP JUNE 1981
 - SCIENCE OF SILICON MATERIAL PREPARATION AUGUST 1982
 - HIGH-SPEED GROWTH AND CHARACTERIZATION OF CRYSTALS FOR SOLAR CELLS NOVEMBER 1982

Possible Workshops During 1983

- HIGH-EFFICIENCY CRYSTALLINE SILICON SOLAR CELLS
- METALLIZATION FOR HIGH-EFFICIENCY, LONG-LIFE CELLS
- ENCAPSULATION MATERIAL TECHNOLOGY FOR SOLAR CELL MODULES
- TEMPERATURE/HUMIDITY AND ELECTROCHEMICAL CORROSION EFFECTS ON CELL AND MODULE DEGRADATION
- CENTRAL-STATION ARRAY DESIGN CRITICAL PARAMETERS
- ROOF-TOP ARRAY DESIGN CRITICAL PARAMETERS
- ARRAY/POWER CONDITIONER ELECTRICAL INTERFACE DESIGN